The Claims

What is claimed as the invention is:

1. A method for real time transmission of information content between a network server and a network client comprising the steps of:

transmitting successive packets of said content from said server to a retransmit module;

assigning at said retransmit module to each of said packets a sequence number and a first timer;

transmitting further each of said packets from said retransmit module to said network client;

transmitting from said network client to said retransmit module an acknowledgment for each of said packets received at said network client;

retransmitting from said retransmit module any of said packets upon expiration of said first timer assigned thereto prior to an acknowledgment for said any one of said packets being received; and

removing from said retransmit module any of said packets upon an occurrance of a predetermined event prior to an acknowledgement for said any of said packets being received.

2. A method as set forth in Claim 1 further comprising:

assigning at said retransmit module to each of said packets a second timer wherein expiration of said second timer is said occurrence of said predetermined event.

3. A method as set forth in Claim 1 further comprising removing from said retransmit module any of said packets upon said acknowledgment for said any one of said packets being received prior to expiration of said first timer.

4. A method as set forth in Claim 1 further comprising placing said acknowledgment for differing ones of said packets into a coalesced acknowledgment.

5. A method as set forth in Claim 1 further comprising:

maintaining the bandwidth of said successively transmitted packets to the lesser of a congestion window initially determined to be maximum segment size and a client window size no greater than the size of a UDP socket input buffer at said client.

6. A method as set forth in Claim 5 wherein said congestion window is increased by the size of each packet for which an acknowledgment is received.

7. A method as set forth in Claim 6 wherein said congestion window is increased until said congestion window exceeds a predetermined threshold, and increases thereafter by said maximum segment size for each acknowledgment received.

8. A method as set forth in Claim 7 wherein said threshold is determined by a window size that is last known to be error free in receipt of said successively transmitted packets.

9. A method as set forth in Claim 7 wherein said threshold is, upon retransmitting of any of said packets, set to the greater of ½ of the current congestion window size or maximum segment size.

10. A method as set forth in Claim 9 wherein said congestion window is reset to said maximum segment size.

11. A method as set forth in Claim 1 wherein said first timer is determined as a function of round trip time defined as a running average time between transmission of each packet and receipt of an acknowledgment for such packet and a standard deviation of each round trip time.

12. A method as set forth in claim 11 wherein said function is the sum of said running average plus four times said standard deviation.

13. A method as set forth in claim 11 wherein said first timer is further initially set at one and one-half times said function.

14. A method for acknowledging receipt of packets sent from a network server to a network client comprising steps of:

transmitting successively packets from said server;

receiving at said client several of said packets;

placing into a coalesced acknowledgment an ID of a first one of said several of said packets received at said client;

adding to said coalesced acknowledgment a bit map identifying selected other ones of said several of said packets received at said client; and

transmitting to said server said coalesced acknowledgment.

15. A method as set forth in Claim 14 further comprising sequentially assigning a sequence number as said ID to each of said successively transmitted packets.

16. A method as set forth in Claim 15 wherein said coalesced acknowledgment is sent upon said sequentially assigned sequence numbers being wrapped.

17. A method as set forth in Claim 16 further comprising sending an acknowledgment for any packet having a sequence number out of sequence with said sequence number of an immediately received one of said packets.

18. A method as set forth in Claim 15 wherein said coalesced acknowledgment is sent upon expiration of a predetermined time from a prior coalesced acknowledgment being sent

19. A method as set forth in Claim 18 wherein said coalesced acknowledgment is sent upon expiration of said predetermined time in the event in the event said client has unacknowledged ones of said packets.

20. A method a set forth in Claim 15 wherein said coalesced acknowledgment is sent when said bitmap is full.

21. A network for real time transmission of information content between a network server and a network client comprising:

means for transmitting successive packets of said content from said server to a retransmit module;

means for assigning at said retransmit module to each of said packets a sequence number and a first timer;

means for transmitting further each of said packets from said retransmit module to said network client;

means for transmitting from said network client to said retransmit module an acknowledgment for each of said packets received at said network client;

means for retransmitting from said retransmit module any of said packets upon expiration of said first timer assigned thereto prior to an acknowledgment for said any one of said packets being received; and

means for removing from said retransmit module any of said packets upon an occurrence of a predetermined event prior to an acknowledgement for said any of said packets being received.

22. A network as set forth in Claim 21 further comprising means for assigning at said retransmit module to each of said packets a second timer wherein expiration of said second timer is said occurrence.

23. A network as set forth in Claim 21 further comprising means for removing from said retransmit module any of said packets upon said acknowledgment for said any one of said packets being received prior to expiration of said first timer.

24. A network as set forth in Claim 21 further comprising means for placing said acknowledgment for differing ones of said packets into a coalesced acknowledgment.

25. A network as set forth in Claim 21 further comprising:

means for maintaining the bandwidth of said successively transmitted packets to the lesser of a congestion window initially determined to be maximum segment size and a client window size no greater than the size of a UDP socket input buffer at said client.

26. A network as set forth in Claim 25 wherein said congestion window is increased by the size of each packet for which an acknowledgment is received.

27. A network as set forth in Claim 26 wherein said congestion window is increased until said congestion window exceeds a predetermined threshold, and increases thereafter by said maximum segment size for each acknowledgment received.

28. A network as set forth in Claim 27 wherein said threshold is determined by a window size that is last known to be error free in receipt of said successively transmitted packets.

29. A network as set forth in Claim 27 wherein said threshold is, upon retransmitting of any of said packets, set to the greater of ½ of the current congestion window size or maximum segment size.

30. A network as set forth in claim 29 wherein said congestion window is reset to said maximum segment size.

31. A network as set forth in claim 21 wherein said first timer is determined as a function of round trip time defined as a running average time between transmission of each packet and receipt of an acknowledgment for such packet and a standard deviation of each round trip time.

32. A network as set forth in claim 31 wherein said function is the sum of said running average plus four times said standard deviation.

33. A network as set forth in claim 31 wherein said first timer is further initially set at one and one-half times said function.

34. A network for acknowledging receipt of packets sent from a network server to a network client comprising:

means for transmitting successively packets from said server;

means for receiving at said client several of said packets;

means for placing into a coalesced acknowledgment an ID of a first one of said several of said packets received at said client;

means for adding to said coalesced acknowledgment a bit map identifying selected other ones of said several of said packets received at said client; and

means for transmitting to said server said coalesced acknowledgment.

35. A network as set forth in Claim 34 further comprising means for sequentially assigning a sequence number as said ID to each of said successively transmitted packets.

36. A network as set forth in Claim 35 wherein said coalesced acknowledgment is sent upon said sequentially assigned sequence numbers being wrapped.

37. A network as set forth in Claim 36 further comprising means for sending an acknowledgment for any packet having a sequence number out of sequence with said sequence number of an immediately received one of said packets.

38. A network as set forth in Claim 35 wherein said coalesced acknowledgment is sent upon expiration of a predetermined time from a prior coalesced acknowledgment being sent.

39. A network as set forth in Claim 38 wherein said coalesced acknowledgment is sent upon expiration of said predetermined time in the event in the event said client has unacknowledged ones of said packets.

40. A network a set forth in Claim 35 wherein said coalesced acknowledgment is sent when said bitmap is full.

41. A computer readable medium containing a program which implements a procedure for real time transmission of information content between a network server and a network client comprising:

transmitting successive packets of said content from said server to a retransmit module;

assigning at said retransmit module to each of said packets a sequence number and a first timer;

transmitting further each of said packets from said retransmit module to said network client;

transmitting from said network client to said retransmit module an acknowledgment for each of said packets received at said network client;

retransmitting from said retransmit module any of said packets upon expiration of said first timer assigned thereto prior to an acknowledgment for said any one of said packets being received; and

removing from said retransmit module any of said packets upon an occurrence of a predetermined event prior to an acknowledgement for said any of said packets being received.

42. A computer readable medium as set forth in Claim 41 further comprising assigning at said retransmit module to each of said packets a second timer wherein expiration of said second timer is said occurrence of said predetermined event.

43. A computer readable medium as set forth in Claim 39 further comprising removing from said retransmit module any of said packets upon said acknowledgment for said any one of said packets being received prior to expiration of said first timer.

44. A computer readable medium as set forth in Claim 41 further comprising placing said acknowledgment for differing ones of said packets into a coalesced acknowledgment.

45. A computer readable medium as set forth in Claim 41 further comprising:

maintaining the bandwidth of said successively transmitted packets to the lesser of a congestion window initially determined to be maximum segment size and a client window size no greater than the size of a UDP socket input buffer at said client.

46. A computer readable medium as set forth in Claim 45 wherein said congestion window is increased by the size of each packet for which an acknowledgment is received.

47. A computer readable medium as set forth in Claim 46 wherein said congestion window is increased until said congestion window exceeds a

predetermined threshold, and increases thereafter by said maximum segment size for each acknowledgment received.

48. A computer readable medium as set forth in Claim 47 wherein said threshold is determined by a window size that is last known to be error free in receipt of said successively transmitted packets.

49. A computer readable medium as set forth in Claim 47 wherein said threshold is, upon retransmitting of any of said packets, set to the greater of ½ of the current congestion window size or maximum segment size.

50. A computer readable medium as set forth in Claim 49 wherein said congestion window is reset to said maximum segment size.

51. A computer readable medium as set forth in Claim 41 wherein said first timer is determined as a function of round trip time defined as a running average time between transmission of each packet and receipt of an acknowledgment for such packet and a standard deviation of each round trip time.

52. A computer readable medium as set forth in Claim 41 wherein said function is the sum of said running average plus four times said standard deviation.

53. A computer readable medium as set forth in Claim 41 wherein said first timer is further initially set at one and one-half times said function.

54. A computer readable medium for acknowledging receipt of packets sent from a network server to a network client comprising steps of:

transmitting successively packets from said server;

receiving at said client several of said packets;

placing into a coalesced acknowledgment an ID of a first one of said several of said packets received at said client; and

adding to said coalesced acknowledgment a bit map identifying selected other ones of said several of said packets received at said client; and

transmitting to said server said coalesced acknowledgment.

55. A computer readable medium as set forth in Claim 54 further comprising sequentially assigning a sequence number as said ID to each of said successively transmitted packets.

56. A computer readable medium as set forth in Claim 55 wherein said coalesced acknowledgment is sent upon said sequentially assigned sequence numbers being wrapped.

57. A computer readable medium as set forth in Claim 56 further comprising sending an acknowledgment for any packet having a sequence number out of sequence with said sequence number of an immediately received one of said packets.

58. A computer readable medium as set forth in Claim 55 wherein said coalesced acknowledgment is sent upon expiration of a predetermined time from a prior coalesced acknowledgment being sent.

59. A computer readable medium as set forth in Claim 58 wherein said coalesced acknowledgment is sent upon expiration of said predetermined time in the event in the event said client has unacknowledged ones of said packets.

60. A computer readable medium a set forth in Claim 55 wherein said coalesced acknowledgment is sent when said bitmap is full.

61. A computer network comprising:

a server operative to send successive packets into said network;

a network client which receives said packets from said network;

a retransmit module responsive to said packets sent by said server to assign to each of said packets a sequence number and a first timer, said transmit module further transmitting each of said packets into said network, said network client further transmitting to said retransmit module an acknowledgment for each of said packets received at said network client, said retransmit module further retransmitting any of said packets upon expiration of said first timer assigned thereto prior to an acknowledgment for said any one of said packets being received, and

said retransmit module further removing any of said packets upon expiration of said second timer assigned thereto.

62. A network as set forth in Claim 61 wherein said retransmit module further assigns a second timer to each of said packets wherein expiration of said second timer is said occurrence of said predetermined event.

63. A network as set forth in Claim 61 wherein said retransmit module removes any of said packets upon said acknowledgment for said any one of said packets being received prior to expiration of said first timer.

64. A network as set forth in Claim 61 wherein said client is further adapted to place said acknowledgment for differing ones of said packets into a coalesced acknowledgment.

65. A network as set forth in Claim 61 where in said server further maintains a bandwidth of said successively transmitted packets to the lesser of a congestion window initially determined to be maximum segment size and a client window size no greater than the size of a UDP socket input buffer at said client.

66. A network as set forth in Claim 65 wherein said congestion window is increased by the size of each packet for which an acknowledgment is received.

67. A network as set forth in Claim 66 wherein said congestion window is increased until said congestion window exceeds a predetermined threshold, and increases thereafter by said maximum segment size for each acknowledgment received.

68. A network as set forth in Claim 67 wherein said threshold is determined by a window size that is last known to be error free in receipt of said successively transmitted packets.

69. A network as set forth in Claim 67 wherein said threshold is, upon retransmitting of any of said packets, set to the greater of ½ of the current congestion window size or maximum segment size.

70. A network as set forth in Claim 69 wherein said congestion window is reset to said maximum segment size.

71. A network as set forth in Claim 61 wherein said first timer is determined as a function of round trip time defined as a running average time between transmission of each packet and receipt of an acknowledgment for such packet and a standard deviation of each round trip time.

72. A network as set forth in Claim 71 wherein said function is the sum of said running average plus four times said standard deviation.

73. A network as set forth in Claim 67 wherein said first timer is further initially set at one and one-half times said function.

74. A computer network comprising:

a network server which successively transmits packets into said network;

a network client which receives said packets from said network;

said client being adapted to place a coalesced acknowledgment an ID of a first one of said several of said packets received at said client, and further adapted to add to said coalesced acknowledgment a bit map identifying selected other ones of said several of said packets received at said client, and further adapted to transmit to said server said coalesced acknowledgment.

75. A network as set forth in Claim 74 wherein said server sequentially assigns a sequence number as said ID to each of said successively transmitted packets.

76. A network as set forth in Claim 75 wherein said coalesced acknowledgment is sent upon said sequentially assigned sequence numbers being wrapped.

77. A network as set forth in Claim 76 further comprising means for sending an acknowledgment for any packet having a sequence number out of sequence with said sequence number of an immediately received one of said packets.

78. A network as set forth in Claim 75 wherein said coalesced acknowledgment is sent upon expiration of a predetermined time from a prior coalesced acknowledgment being sent.

79. A network as set forth in Claim 78 wherein said coalesced acknowledgment is sent upon expiration of said predetermined time in the event in the event said client has unacknowledged ones of said packets.

80. A network a set forth in Claim 75 wherein said coalesced acknowledgment is sent when said bitmap is full.